
# NEURILITY:

## CORRELATED, CONVERTED PHYSICAL FORCES.

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UNTIL we have fathomed the possibilities of the physical forces environing us we may not exclude them from the production of "vital" phenomena.

Physical laws confessedly govern, intrinsically, every atom of which our globe is composed.

These same laws bind us extrinsically to a universe similarly controlled.

Such men as Faraday, after lives of intimacy with many of Nature's operations, conclude that there are, so far as we know, limitless possibilities inherent in these modes of Energy. The study of organic chemistry, alone, inclines one to a reverential awe of the immensities of its resources; and what is Chemistry but the effects of Force upon atoms?

Dr. Lehman, in his Chemical Physiology, properly claims that: "A proof of the existence of a purely vital force is only to be obtained by an exclusion of every physical force."

Having made inroads upon the claims of a pure vitality, by finding ourselves not under special laws alone, where can we draw the line when, *imprimis*, man is subject to the laws of gravity?

Not attempting to discuss the nature of bioplasm, its origin, metamorphoses nor the forces governing it: I only try, herein, to indicate, what seems to me, the nature of the *vis nervosa* acting upon "formed" material.

Taking the ganglion as the correlating, co-ordinating centre of nerve energy in the annelides, and on the ground that telegraphic communication requires the intervention of a transmitting medium, the protozoa with the sole abilities of assimilation and locomotion by pseudopodia may not be denied nerve functionment any more than we may deny the existence of the undemonstrated vaso motors or trophic nerves.

We have learned a lesson, from once considering the rotifera lowly organized.

Higher up, the stomata, with commissurally related nerves combine the faculties of prehension and locomotion by cilia—an improvement upon pseudopodia—with the necessary means of using an oral aperture.

These ganglionic combinations of nerves conveying different faculties, or the nucleus of the animal itself, if neither commissures nor ganglia exist, constitute to all intents and purposes, needed by that animal, *a mind*. Of course, of very low grade, but how can we separate our purely reflex involuntary nervous system from the nervous system of the same low stomata? Even the mental emotions, demonstrably situated in the cortices of the hemispheres, are connected with involuntary phenomena, their interexcitation being controlled in proportion to intellectual development or training.

Habit, rearing, external impressions, circumstances, are omnipotent to mould our modes of motion, thoughts and action, and what required an intellectual effort at one time, at another becomes "second nature" to us, and we may mechanically perform what before required concentrated thought. Thus, the trained animal involuntarily shrieks at a glance from its cruel master, we may say, in a purely reflex (cultivated) way. The retinal impression exciting the nerves concerned in phonation.

Back to the annelides, the faculties of the centipede are decidedly ganglionic, the central spinal system cross-

ing at ganglia the locomotor nerves and the head ganglion seemingly of no more importance than any other.

Where a number of nerves unite in synchronous intelligent functionment, in any animal, this union affords something very much akin to, if it does not constitute *brain*.

There is the same descending scale in intelligence between man and man, nation and nation, as between man and animals. Comparative anatomy, histology and biology bear out this commissural hypothesis clearly.

Wherever the evolution of intelligence apparently militates against the soul being a separate entity we may overcome such conclusion by granting this Essence not only to idiots but to animals generally, even down to the lowest infusoria, including plant life, even.

Nor would this be inconsistent with an Omniscience, which is also Omnipresent, Infinite. Rather implying the pervasion of every atom of the universe with Intelligence.

The modes of energy manifesting themselves to our senses as Sound, Heat, Light and Electricity, may not be stigmatized as paltry or insufficient to produce all the phenomena of life, until, as Lehman proposes, they can be excluded, which would argue a knowledge possessed by no one living or who may live.

The undulatory theory we may fairly consider as established. Immediately we are made aware of interstitial forces we did not dream of before.

At the lowest appreciable end of energy, regarding the forces as we know them to be, correlated and convertible, is found sound.

Now sixteen vibrations of the tympanum in one second, is the first intimation we have of this form of energy. Shall we say there is nothing below this referable to physical forces? Let us first view sound as a low form of energy in its effects upon our sensorium.

"When the single impulses are fewer than sixteen or more than forty thousand in a second, the ear is no longer sensible of a musical sound, in the first case it either receives an undefined hum, or else it distinguishes the

individual strokes upon the tympanum and becomes sensible of them as distinct blows ; in the latter case there is an impression of a sharp, but equally indefinite, shrill or hissing noise.

"The limits of susceptibility of the ear for musical impressions lie between sixteen and forty thousand impulses per second.

"Between these vibrations, E of the double bass 41½ vibrations in orchestral instruments, or some pianos A with 27½, and the piccolo flute with 4752, we have the limits of instrumental music."—*Schellen's Spectrum Analysis, p. 41.*

As exemplifying what cultivation may do for our appreciabilities, and going to show a strong probability that our senses are developing and that future generations may see what we are now incapable of seeing ; that we do now hear what our forefathers did not, I append the following from *London Society*, a journal presumably authority in such matters.

"Musical Pitch.—It is well known to musicians that during the last century there has been a gradual rise in the pitch of musical notes; that is, the note which formerly used to be regarded, say as 'A,' has gradually become considered flatter and flatter, so that the sound produced by a given key on a modern instrument is sensibly sharper and more acute than that given by the corresponding key on an older instrument. To so great an extent has this variation now arrived that the highest concert pitch of the present day is at least a tone above that in use in 1750; that is, the note which is now regarded as B flat, or even almost A natural, was considered to be B natural, or close to it, in the first half of last century, while even during the last fifty years there has been a rise from a semitone to a semitone and a half in pitch. * * * * This difference of pitch is acoustically expressed by saying that the number of vibrations per second required to give a certain note is now considerably greater than was formerly the case."

*Crescit enim cum amplitudine rerum vis ingenii.*

What becomes of the slow undulations beyond sound?

We call that end silence, merely because we do not understand anything it may do.

Here we have a mode of Energy losing itself so far as we are concerned. But it may not be lost, and we will return to it presently.

After 40,000 vibrations of constantly increasing Hogarthian lines, there is again "Silence," and here we have an interstitial force whose undulations have become too rapid, too numerous to convey any impression to our brains. The first silent space was too slow in its movements to affect our auditory nerves.

Then the question arises: How do we know our nerves are not receptacles of these "Silent" forces? We are convinced of their existence, and beyond this rapid silent space we are sensible of heat and light. Now if we have nerve-fibres responding to impressions of Sound and Light, why may we not, also, have fibres appreciating the intermediate undulations?

If you consider the difference between our senses too great to admit of any such analogy, remember that, notwithstanding the disparity between light and sound, we know the same tissue conveys both impressions. Then, notwithstanding these disparities in modes of ultimate "vital" action, the gap is no greater between sound and light than between either and motility or the tactile sense.

So between 40,000 and 450,000 impulses there is a space apparent only at the rapid end as Heat, just before merging into Light. But between Heat and Sound the silent space is neither Heat, Light nor Sound.

There is an analogy between the colors of light and heat and the musical notes. Tyndall says the eye perceives an octave of colors, and the ear eleven and a half octaves of sound. These colors, from the least refrangible or heaviest red, at 450 billion, to the violet, which is most refrangible and lightest, so to speak, with 800 billion vibrations, comprise this octave, the seven cardinal colors.

After these pulsations, there is another "Silent" space. Is it silent? Fortunately, Fluorescence has enabled us

to make manifest in terms of color within the visible spectral limits what otherwise would have been as unresponsive to our senses as are the other silent spaces. Fluorescence is a retardation of the invisible rays of this outlying force, and phenomena are rendered evident in other terms. The invisible is translated, and here we are in *terra incognita* which, to the timid and conservative, is always a "terrible country."

A colorless solution of Sulphate of Quinia diffuses in this invisible space a peculiar blue color. Sir John Herschel and Sir David Brewster examined the subject, but Prof. Stokes gave the true retardation theory thereof.

Here it might be well to inquire if there is any interdependence between this fluorescent property of quinia in its absorption or conversion of the invisible spectral rays, and the well-known anti-pyretic properties of quinia in its absorption or conversion of animal heat. This could lead to the discovery of even more efficient febrifuges than quinia, if the connection was inseparable.

But this third "Silent" or invisible space produces chemical changes, although this cannot be claimed as peculiar to any part of Energy from Sound to Electricity. Certain Nitrites explode when a given note on any instrument is touched, and loose combinations may detonate readily by a slight jar, responding to a slower force than Sound.

The electrolysis of water is an evidence of the universality of this disruptive chemical power of all forces, when viewed with the facts just stated, and with the known molecular disintegrating power of the intermediate forces, including the so-called chemical force.

The chemical combining power of all forces, from the slow and beautiful processes of crystallization to the formation of water by the combustion of Hydrogen and Oxygen with an electrical spark, may be similarly cited.

La Place calculates the rapidity of gravitation to be seven million times that of light, and physicists generally are inclined to include this as a mode of the same universal Energy.

There remains but to be mentioned Electricity as the

intensification of these rapid vibrations (excluding gravitation) to arrive at a suitable place to pause and review our ground.

The distances between these forces seem to be regulated by a geometrical progression similar to the planetary "law" of Bode.

The media for these pulsations we will ignore. If different degrees of attenuation of matter throughout "space" be conceived, it will bridge over any necessity for speculation upon the character of Energy-transmission, so far as the atoms acted upon are concerned.

Whether the motility imparted to the muscular fibres passes over the nerves as Electricity or "Nerve force" matters little. The nerves conduct and respond to Electricity, but it is doubtless converted into a lower form of Energy, as metals interpolated in nerve circuits fail to cause distal phenomena when applied electricity is proximal. I do not say nerve-force is electricity—far from it; no more will I grant that heat *per se* passes over nerves. The relative speed of these forces *in vacuo*, etc., compared with the smaller rates of sensory and motor transmission is not an argument against the convertibility of one mode into another. Electricity may be retarded from 288,000 miles a second *in vacuo* to 190,000 or 3,000 or less in denser media.

Hence I will be accused of saying that motility is magnetism. Not so. The laws of light and sound in reflection from curved and plane surfaces are identical—yet sound is not light in the general acceptation. Motility may have nothing to do with magnetism, but contractions are caused by each as surely as reflection is produced by light and sound.

The optic nerves conduct light-impressions, and as to whether light as such is conducted to the tubercula quadrigemina, or transformed at the retina into nerve-force of less intensity, the fact remains that nerves are susceptible to impressions of light.

The auditory nerves undoubtedly conduct sounds. The afferent nerves throughout the body conduct heat sensations and excite reflex motions. Nerves, therefore,

admittedly convey Sounds, Heat, Light and Electricity. What then is the character of the other remaining forces producing secretory and muscular activity?

As to the former, when we have a great division of physical Energy between Electricity and Light, *concerned* in chemical effects, both disintegrating and combining, where is the necessity for our calling in a metaphysical vitality when the chemical energy answers every purpose?

Ganot rather favors this view in a couple of lines in Atkinson's edition p. 776.

Certain involuntary reflex acts may be and are caused by mere heat, as such, as in the motor ganglia of the heart for example. And the iris responds to light impressions markedly in photophobia, less in the operation of accommodation. Sounds reflexly affect the tympanic tensions, and electrical muscular contractions need be but mentioned in this connection.

Then we have sound, heat, light and electricity, causing reflex movements of muscular tissue, going to show the unity of the energy and selective ability of certain nerves as to the forces to which they will respond.

As to the passage of these physical influences among the molecules of the axis cylinder we are no more concerned for present purposes than with the exact molecular disturbances of polarity in the passage over wires.

Suffice it that nerves conduct and efficiently isolate or insulate their forces from adjacent tissues by means of the medullary substance and neurilemma. But as to the method by which these *changes* may be effected we may refer to the evolution of heat by electrical retardation as in firing mines with the attenuated platinum wire.

De La Rive produced sounds from currents of electricity, (Ganot p. 696), and light from the same source is a familiar production.

The variability of the sizes and numbers of nerve fibres to a part we might infer has to do with the effect to be produced at that part.

It is noticeable that the sympathetic ganglia and fibres

form great plexuses where a definite effect is to be produced.

One nerve fibre may not only carry all these forces successively but at the same instant, and in varying intensities on the principle of the multiplex telegraph.

The telephone might serve to illustrate the conversion of electricity into sound, indirectly—a mechanical principle interfering with its direct applicability, but that very interference causes a great resemblance between the telephonic and laryngeal sounds, each being similarly operative—the one by electrical and the other by neural vibrations or impulses, regulated from a central station converted into attractions of the metal diaphragm and vocal parts.

The necessity for a separate set of vaso-motor fibres for dilatation ceases by a correct appreciation of physical forces, particularly electrical.

Para-magnetism and dia-magnetism will account for all muscular activities. Thus in contraction the ultimate fibres assume the zigzag shape of a para-magnetic body; under the influence of the ordinary current setting equatorially between the poles. In extension, (if not passive) the fibres set axially between the two poles.

A single force over the same wire produces these diametrically opposite phenomena.

But, you say, this is true only of particular substances—one being positively attracted, the other repelled. Read further, and you will see that by a very slight change in condition, as warmth, etc., within the capacity of nerves to furnish, the same substance becomes paramagnetic or diamagnetic. The oxygen molecule, for example, is at one instant attracted, and another repelled.

Here is assimilative ability of glandular structure accounted for. Glands attract or repel certain ingesta according to location or function, the secreto-motor nerves assisting.

Œsophageal inverted action can thus be accounted for. The dilatation in emesis being caused by the sensory fibre below the bolus sending a dilating force above the offending substance causing its expulsion.

Rigor mortis may be a simultaneous escape of all forces from the muscles producing symmetrical action upon both flexors and extensors accompanied with temporary elevation of temperature.

Batrachians tetanizing in water over 100° Fahrenheit, and regaining their normal condition at 45°, does not show heat not to be concerned in nerve force. It is evidence that the cool-blooded animal is vitalized by a lesser force than serves the purposes of the warm-blooded.

Bodily heat may be considered as largely excrementitious, evolved in the conversion of other forces, and the mechanical equivalent of heat in the muscles need not thus alone betoken the tissue changes occurring. The ratio between heat evolution and production of effete matter in tissues is not always constant.

The star fish is convulsed in fresh water having the same temperature as its native briny element, which may be taken to mean that the nerves of all animals are adapted to their customary surroundings; and further along we will see that the sea-water could impart a nerve energy to ophiura he could not obtain in fresh water.

Pain may be analyzed by this view as consisting of a sensation, within the limits of all modes of Energy, beyond the capacity of the nerve to sustain, or the volume of force passing over its wonted fibre may be too great, and cause the sensation of pain.

A common experiment of singers is to gradually swell the volume of a note to which a cracked glass responds until the vibrations break the glass by their amplitude.

Light is light, but its *volume* may be so increased, the amplitude of each vibration remaining the same as that to which the optic is accustomed, until the pain becomes unbearable.

The application of the actual cautery causes intense pain through the sensory nerves, probably either by its volume or the unwonted impulse, but, as soon as the heat is raised to the white intensity the actual cautery does not cause pain. This may be due to the white heat approximating the limits of normal transmission.

Painful pressure is but the augmentation of the volume of touch sensations.

The epileptic aura passing over the olfactory nerves gives the impression of a horrible stench. Stench, as explained by the interference of function, constitutes pain to these nerves.

The auditory apparatus is made aware of painful sensations by the shrillness or volume of sounds—vibrations either in intensity of pitch or in number of similar impulses straining the nerves beyond their usual capacity.

In the electrical eel we have a direct proof of the ability of the nervous tissue to contain and accumulate electricity. The electrical cells and connecting peduncles are identical with nerve structure, and the discharge of electricity from the animal is followed by nervous prostration.

Tentatively we may regard nerve cells operating as electrical batteries with cerebric or other acids acting as polar solvents. "The solvent alters the direction of the current." (Ganot, p. 634.) Thus acids and alkalies may depress or exalt nerve function.

"Sulphur and phosphorus are especially essential to the integrity of protein." (Lehman, p. 105.)

"Sulphur is a non-conductor of heat and electricity, and becomes negatively electrical by heat and friction." (Brande & Taylor's Chemistry, p. 213.) "Gamma sulphur evolves 11° of heat at a temperature of 100° "—(Roscoe, p. 127.)

Phosphorus does not conduct electricity either solid or in solution.

"The brain and other nerve centres contain Protagon, of which phosphorus forms an essential constituent easily decomposed into glycerin, phosphoric acid, several fatty acids and an ammonium base called neurine." (Roscoe, p. 437.)

I quote the foregoing to show that in the nerve centres we contain the two essentials for the production of a force in the manner of electrical generation, the two dissimilar fluids, acid and alkaline, acting upon the granular contents contained within the limitary membrane of the cell.

The small amount of latent heat held by phosphorus and sulphur have a peculiar significance. Water has a latent heat of 966.6°, sulphur only 17°, and phosphorus the smallest of all, 9° Fahrenheit.

Phosphorescence may be regarded as the reflection or excretion in light terms of every form of energy impinging upon the phosphorescent body. Phosphorus hence in its contiguity to, or constituency of, nerve cells may, from this convertible property, transform or so retard the vibrations of other forms of energy as to place the force within the transmitting power of the nerve fibres.

Its irritant properties could be attributed to this conversion occurring peripherally to the detriment of nerve action, the proper location for its effects being centric and, when medicinally administered, proving tonic to the centres.

The low specific heat of phosphorus, in Haswell's Engineering, is placed at 0.189, water being 1.

If one pound of coal will heat one pound of water to 100°, one-fifth of a pound will heat one pound of phosphorus to the same degree.

Phosphorus and sulphur are sensitive to small efforts at temperature raising, while they readily yield caloric and refuse to absorb it. These peculiarities would render them *par excellence* the constituents of protein and account for the evolution of heat and its conveyance through protein, both in animal and vegetable existence, but their force-converting abilities seem their most useful function in nerve-cell composition.

The work performed by a muscle is said to represent the amount of oxidation liberating heat in the muscle, but heat is also evolved in the brain where less of these molecular changes might be expected to occur passing out without oxidation. Cut the sciatic nerve and produce artificial motion in the limb, will the heat passed off be equal to that produced when the nerve is intact under the same motion? Why also does not the oxidation of muscular tissue in cold-blooded animals throw out perceptible heat?

I therefore am inclined to believe that heat is an ex-

crementitious product of the nerve forces in motor production ; also that in common with other forces, heat is absorbed by the afferent distribution of nerves in the serous coats of the blood-vessels and by the nerves of the intestinal villi.

Tactile sensibility, the senses of taste and smell may be considered as modifications of one sense. Thus Bradley (p. 61.) speaks of the combination of the senses of hearing and smelling in the Crustacea.

Touch may be accounted for by pressure closing a nerve circuit in the pacinian corpuscle.

Taste, by similar contact with substances in solution in the taste buds of the circumvallate papillæ ; and, right here, interesting reference can be made to an article by Edwin Smith, M. A., in the Chemical News, 1870, upon Vegetable Electromotors, wherein he shows that "pairs of eatables which generally go together, such as pepper and salt, coffee and sugar, almonds and raisins, generated a more or less strong voltaic current ; bitters and sweets, pungents and salts afford true voltaic couples in consequence, doubtless, of the mutual action of an alkaloid salt and an acid or its equivalent."

Habit in the appreciation of nerve impressions is everything, and a volume could be written about our dependence upon habit and culture for the right or wrong conception of all external entities.

Volatile anasthetics may operate by their inherent forces interfering with the pulsations normally passing over nerves ; or, simpler still, ether penetrated to nerves may just as efficiently abstract heat or other force therefrom as when applied externally.

An interesting field lies in the æsthetics of colors, sounds and scents. These act as potently upon the nerves by their combinations to intoxicate as do the inebriant narcotics. Their surfeit may even first excite and then depress precisely as does this class of remedies.

The effect of colors upon animals has had but passing notice. The rage of the bull and the turkey upon spying red fabrics ; instances of alcoholic drunkenness being rendered more profound by red lamps afford a study capable of profitable revelations.

May it not be that green is the most grateful color to the eye because it has the intermediate place in the spectrum and exercises the retina less?

Gaudy colors are notoriously offensive to the refined, as are stenches, strong liquors and vulgar excitements of any kind.

In the management of the sick room the utility of sounds, colors and scents is undisputed.

The abstraction of nerve force by the application of cold, as paralysis of the ulnar distribution by ice at the olecranon is another instance of the relation of heat to the other physical forces.

The analogy between magnetic and muscular contractile phenomena may be considered strengthened, if it is true as asserted that the softness or flaccidity of muscular fibres renders the tissue capable of less durable contractions than when the muscles are firm and hard.

Iron is capable of but temporary magnetism: steel when once coerced retains the magnetism indefinitely.

Notably rigor mortis ends with the softening of the fibres, and the strong man is said to have hard muscles.

The slow response of the unstriated muscles and the more rapid of the striated to nerve stimuli, may be likened to these features of harder and softer metals. Moreover the involuntary muscles hold their tonicity longer, as if coerced slowly and durably.

Now we pass to an extremely interesting consideration: the modes of operation of the secretory system. But we must first look at the occlusion of forces by all unorganized and organized compounds, and it will not require much space, for we deal with facts found recorded in all works on chemistry and physics.

All elements absorb Energy in varying proportions, yielding it up as circumstances call for it, and not always is it rendered back in the same form as absorbed. Thus $H_2 SO_4$ plus Aq. = heat. CaO plus Aq. = heat.

Roscoe(p. 442.) says: "The heat given off by coal in combustion is, in heat vibrations, a measure of the light vibrations given it by the sun,"

Miller (vol. 1, p. 52.) mentions the liberation of light from fluor spar, phosphorite &c.

The same page speaks of the light developed in crystallization, the next page Matteucci's experiments as showing that the production of phosphorescence from fishes undergoing decomposition does not appear to be due to a process of oxidation as the light is not sensibly diminished by immersion in nitrogen, hydrogen or $CO_2$.

"A temperature of 100° seems to be most favorable to the production ot this remarkable light, and below 100° it disappears."

"Phosphorescence is the vital act of the marine animal." (p. 152.)

It may be vital because performed by an animal, but it is no less physical than the luminosity of decaying vegetable matter or the post mortem production of light recorded by Carpenter in his Physiology.

A large portion of Miller's Chemical Physics is devoted to the varions evidences of the part the forces serve in combination and reactions of matter.

The frigorific chemical combinations instance the disappearance of heat from one body and its occlusion as latent in another.

I wished to pave the way to a consideration of the strong probability that the atomic energetic constitution of ingesta determined the effect to be produced and the nerves upon which it would act, as instance the predilection of Croton Chloral Hydrate for the 5th pair.

The diverse physical phenomena transmitted over homogeneous nerve tissue proclaims alone the unity of the forces acting upon them. But there is a decided diversity in the sizes of fasciculi of nerves and their proximity to ganglia.

The multiplication of ganglia in the solar plexus and the ramifying thence of short fibrillæ by a "scientific use of the imagination" we might conclude had much to do with the accumulation and use of the chemical or motor forces at work in the glandular structure of the viscera.

Each villus contains its nerve,—Is it not fair for us to infer that the nerves are there for a purpose and that purpose the reception of the forces thrown out by the disintegrating food? As the lacteals and portal vessels take up the liquid or emulsified particles, so may the serous and mucous nerves take up heat, light, electricity or chemical energy.

The nascent condition of the organized forces being more assimilable precisely as elementary pabulum nourishes the body by being taken from organized food.

It is demonstrable that all food contains various forms of energy bound up with the atoms in different proportions, constant for the same compound, and these forces are yielded up to the nerves by the disintegration of the articles in the stomach and intestines in the presence of and assisted by the gastric, biliary, pancreatic and other secretions.

And just as these secretions are formed from the food taken, and react upon additional food, so the forces absorbed could react upon food for the extraction of heat, chemical force or electricity, different degrees of these would precipitate from different boluses the ingredients intended for particular glands.

The popular ascription of heat, coolness, strength &c. of the aromatics, salines and bitters to the taste and sensations along the *primæ viæ* can thus be literally descriptive.

Electrolysis of water may readily occur in visceral glands, oxygen being repelled from the negative and attracted to the positive influence, the same anion magnetic under ordinary circumstances is diamagnetic with high temperature. (Ganot, p. 751, quoting Faraday.)

Read the marvelous differential effects mechanical, physiological, chemical and luminous of the Ruhm-

Korff coil to appreciate the capabilities of this single division of Energy with the analogical operations of kindred forces.

Thus the gland by its energy selecting nerves determining exactly what ingredients shall be absorbed or repelled, and this has been the mysterious glandular activity. "Glandular and intestinal activity increases heat of blood and in proportion to act of nutrition so is production of heat." (Dalton, p. 308.)

A sympathetic short fine fibre close to a number of powerful ganglia would reasonably have an intensifying effect upon glandular action, and the gastric and enteric distribution is provided with plexuses of such fibres, reminding one of the electric law of heat proportional to square of current and resistance of wire.

Telegraphers find it best to occasionally change the direction of currents through helices, as a relay after long working from a current going one way when finally changed is fitful and erratic in its magnetism for some time after the change.

The current runs indifferently either way, but changes are not readily effected; the molecular revolution in the cores requiring time to be adjusted to the new condition and responding "painfully" at first to a reversal in passage. Thus nerve force passes centripetally or centrifugally. When a feeble current produces contractions passing in one direction, it causes pain when changed. We may say the molecular revolutions in the nerve fibres are not in accord with the, as yet, unwonted direction.

Apropos of energy-absorption by glands, Schellen (pp. 128–129.) speaks of the absorption of light by liquids and solids; and Miller (p. 152, vol. 1.), the reverse operation of phosphorite.

These considerations would explain the differences in the food of animals as well as why the cold and

warm-blooded animals are not similarly affected by identical provender.

Just here Tyndall's Faraday Memorial (p. 138.) explains where the transformations of dynamic into potential energies occur. So we may conceive of all this marvelous light, electrical and fire eating to take place without danger of internal conflagration or explosion.

Alum could produce emesis by withdrawal of energy (of which heat is one mode) from the solar plexus terminals allowing pneumogastric action with active expulsion and by vaso motor intestinal abstraction of energy the serous transudation with catharsis would occur.

Aloes, we can conceive as passing by a multitude of nerve terminals finally coming in contact with the hypogastric or pelvic distribution, instead of abstracting, in this case, imparting its combination of energies. This selective propensity of nerves would answer better why aloes requires a longer time to act, and also why the uterus participates in its effects. The propinquity of the uterine and colic nerves arguing in favor of this thought.

The hydragogues abstractive, the drastics impartive of energy to different parts of the canal.

The effects of narcotics upon the different nerves could be advantageously studied from this standpoint.

The connection between the neurotics and cathartics is well shown in Helleborin and Helleborein, the first narcotic and productive of paresis of motion and sensation the second a cardiac poison and drastic purgative.

Billroth says the temperature of animals poisoned by ammonia falls enormously. Lange finds that, injected into the veins of animals, there is at first a momentary fall of the arterial pressure, followed by a

sudden and enormous rise with a corresponding increase of the pulse rate. Funke says the heart suffers a rapid paralysis.

The latent heat of ammonia is 860°, nearly equalling steam. Is it not reasonable to infer that its abstraction of heat from the human body would cause enormous fall of temperature? Taking the volatility of the article into account, this heat is again yielded to the system, accounting for the rest of the phenomena.

Alcohol in small doses increases, in lethal doses decreases temperature, probably by abstracting what would have been evolved, giving it to the circulation in its excretion in the former case. Small alcoholic doses might then be expected to reduce external temperature. Its latent heat is 364°.

The instantaneous paralysis of the entire system by hydrocyanic acid is intimately connected with the tendency to spontaneous decomposition and instant liberation of its force bearing particles among the nerve tissues. Thus investigations into the amounts of physical energy in each drug taken in connection with its physiological effects, and the microscopic construction of ultimate nerve distributions, would be likely to afford important results.

Allotrophy, isomerism and metamerism speak loudly for the underlying influence modifications of energy occlusion possess in changing the character of similarly constituted compounds. Fever, metastasis, phlegmasiæ, indigestion, impaired nutrition, exhaustion, may all be dealt with satisfactorily from this new hypothesis.

Vernuil says, "tetanus is not regarded as dangerous unless there is an augmentation of heat." This would be indicative of the exhaustive escape of other forces.

The yielding up of energies stored in organized food is not alone the source whence force is derived for our functional centers.

Sunlight affects the growth of plants and their nutrition materially. To a great extent, we are dependent upon its influence more or less directly, to say nothing of the terrestrial death its withdrawal would occur.

Prof. N. S. Davis, at a Mercy Hospital clinic, stated the general nervous impairment of sun-light deprivation, the case being a night-watchman, who, for some years had slept in the day-time, suffering gastric and motor derangement with occipital pain and general innutrition.

The anatomy of the cerebellum, with the pons varolii, its position in the skull, the relative situation of the tubercula quadrigemina connected to the cerebellum by the superior peduncles, at the superior part, and the inferior situation of the origin of the auditory nerves in the floor of the fourth ventricle, with the granting of "reinforcing properties to nerves passing through the cerebellum," would justify us in believing this great organ to be a receptacle, possibly a converter of forces, acting as a rheostat and condenser for the entire nervous system.

Light at one end of the scale, sound at the other. The optic origin superiorly and the auditory inferiorly situated with reference to this organ and the failure heretofore to accord it any function distinct from other parts of the nervous system, all point to some connection at least with this supposition. In other words, the cerebellum is to the nervous system what the spleen is to the vascular system—a diverticulum.

The old ideas of motility, the venereal sense, coordinating powers, forward movements being centered there, one by one abandoned and by exclusion the

deduction that the cerebellum has no function whatever, become at once understood if we assign the general and indifferent force receiving and imparting function to the organ. In comparative anatomy, the central lobe of the cerebellum is constant; the lateral lobes are not, but are added as the faculties of prehension, standing erect, etc., increase, and the lobes enlarge as these abilities become more decided. (Carpenter, p. 514.) As the necessity for more diffusibility and the rapid shifting of energies occur, in that proportion might we expect an increased force-holding reservoir.

Let a person with, *cæteris paribus*, a large cerebellum, cultivate his muscles to the exclusion of his other capabilities, and *for the occasion* considering muscles, concupiscence and intellect as predominating in man, we need not expect to find that individual prone to trouble from the two other sources.

So intellect may, with a large cerebrum, call off energy from the cerebellum, otherwise going to one or both of the other divisions, and the development of satyriasis must be at the expense of muscular and intellectual prostration.

Prof. Curtis, Chicago Medical College, says that the fibres passing into the cerebellum seem to pass out again, which statement favors the reinforcing view.

Prof. Jewell and other neurologists give us an avenue for escape of force from the cerebellum to the sympathetic system through the direct cerebellar tract in the lateral column of the spinal cord, thence to the gray matter of the cord. The pons tract connects the cortex of the brain, and the processus cerebello ad testes complete the connections. The intellectual cells in the cortex may now act as detents or liberators of cerebellar and other ganglionic forces at pleasure or automatically.

Dalton, p. 496, cites recovery of co-ordinating power after two-thirds extirpation of the cerebellum, showing that it does not exclusively preside over this function. The spleen may, as justly, be denominated a vascular co-ordinating gland. Its removal renders occasional vascular engorgement liable. Then the removal of the cerebellum should, by this reasoning, surcharge the other force receptacles–the ganglia.

The following from p.495, Dalton, seems conclusive:

"The pigeon from which the cerebellum, only, has been taken away, is in a constant state of agitation. He is easily excited, and frequently endeavors, with violent struggles to escape from place to place."

Thus Gall's hypothesis and the other ideas that have been advanced to be given up again are reconciled. A case by Carpenter, p. 520, of a tumor on the Pons, causing great sexual desire, would seem to have occasioned a cutting off the intellectual channel. The same page mentions a blow upon the occipnt interfering with sexual functions.

An element here of importance would be the capacity of individual cerebri determining whether a large cerebellum would develop sexuality in that person, though there is such a constitution as large cerebri, cerebellum, muscular development with proportional virility. In which case the proper balance being presumable.

A relatively small cerebellum, whatever the other development of the individual may be, notoriously lessens, as is popularly expressed, the "force" of the person.

"When the form of a body is changed by the action of forces, either the work done against the internal forces will remain stored up as potential energy as in a compressed spring, or will have been replaced by the development of an equivalent of heat. Now

this being premised we see that the energy communicated to any body, or system of bodies, is withdrawn from some other fund of energy previously existing."

This is Atkinson's translation. His application is to machines but addressed to the living it loses none of its significance. Life depends, for all its manifestations upon previously existing energy. This energy is derived from food, for life goes with its withdrawal.

Foods comprise every substance solid, liquid or gaseous necessary to nutrition, and the forces they contain or by which they are organized are those apparent to us under the modes of sound, heat, light, chemical force, electricity with the intermediate non-apparent and extra-non-apparent forces.

A simple logic includes life in the universal conservation of energy.

While organized assimilable food goes to the tissues generally, the functional pabulum of the body is energy, taken up by the nerves and in the cerebellum and ganglia converted, stored up, retarded, augmented there, to manifest itself in functional activity in a myriad ways, as upon muscles, glands, etc., serving the purposes of secretion, motion, etc.

These matters obtaining recognition the way is prepared for the polariscope, spectroscope, galvanometer, thermometer and other instruments for physical investigation to become important adjuncts to medicine.

My conclusions are:

1st. That all the forms of Physical Energy are absorbed by the nerves, and by their cells and ganglia interchanged into different, higher and lower forms, or held as originally absorbed.

2nd. That the Cerebellum is concerned in the storing-up and conversion of forces.

3rd. That plant and animal life is included in the Conservation of Energy. Their physical potential

forces being assimilated from organized food, and from the elementary dynamic forces.

If the medical and scientific Aristarchus could realize the earnest, anxious labor devoted to this subject, through many years, much, even just, criticism might be spared this little paper. Necessarily abridged, the various heads could not be properly treated; an accumulation of notes being, perforce, unused.

Quite recently, Tyndall has alluded to the application of Energy conservation in a psychological way. I do not propose to lose myself in the mazes of that subject; and where in his writings, those of Brown-Sequard or others, intimations of the nature of nerve force accord with this thesis, examination will show that they have generalized, only, and in few words.

Whatever their faults may be, and are, the ideas, as here given, are my own. The main consideration with me being the ever present query: IS IT THE TRUTH?

*186 VINCENNES AVE., CHICAGO,*
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